WORKING PAPER

Technical Executive Summary in Support of "Can Electronic Medical Record Systems Transform Healthcare?" and "Promoting Health Information Technology"

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ABSTRACT

This document summarizes the evidence and analysis that support two papers appearing in *Health Affairs*, Vol. 24, No. 5, Sept/Oct 2005, by Hillestad et al. and by Taylor et al. Three much more complete technical reports can be found at:

Fonkych, K., and R. Taylor, *The State and Pattern of Health Information Technology Adoption*, RAND Corporation, MG-409-HLTH, 2005, available at http://www.rand.org/publications/MG/MG409/.

Girosi, F., R. Meili, and R. Scoville, *Extrapolating Evidence of Health Information Technology Savings and Costs*, RAND Corporation, MG-410-HLTH, 2005, available at http://www.rand.org/publications/MG/MG410/.

Bigelow, J. H., K. Fonkych, C. Fung, and J. Wang, *Analysis of Healthcare Interventions that Change Patient Trajectories*, RAND Corporation, MG-408-HLTH, 2005, available at http://www.rand.org/publications/MG/MG408/.

The following three sections summarize these documents in the order listed.

1. THE STATE AND PATTERN OF HEALTH INFORMATION TECHNOLOGY ADOPTION

This section estimates the degree to which hospitals and physician practices have adopted electronic medical records (EMRs). We also identify factors that correlate with adoption.[1] Our primary source of data was the Healthcare Information and Management Systems Society (HIMSS)-Dorenfest database[2] for the beginning of 2004, which covers nearly 4,000 acute care community hospitals in the United States (three-quarters of the total number) and most physician practices owned by hospital systems. Unfortunately, physician-owned practices were not covered, and their adoption of EMR systems may be lower.[3,4] Further, we tested the reasonableness of our projected ambulatory adoption rates with rates of adoption reported by others. We augmented this database with characteristics of hospitals from the American Hospital Association annual survey of hospitals.[5]

HIT ADOPTION BY HOSPITALS

Exhibit 1.1 shows the overall adoption rates for selected healthcare information technology (HIT) applications. The survey does not have a category for an EMR system in hospitals, so we constructed three definitions from the major components of any EMR system: computerized patient records (CPR), clinical decision support (CDS), and clinical data repository (CDR). A hospital has an "Upper Limit EMR" if it has already installed these three components or reports having signed a contract with a vendor to purchase them. A hospital has a "Partially Integrated EMR" if the same vendor has supplied at least two of the three components. A hospital has an "Integrated EMR" if the same vendor has supplied all three components. Exhibit 1.1 provides some contract-based measures of adoption of other major clinical HIT applications: PACS (picture archiving clinical systems), CPOE (computerized physician order entry), and ambulatory EMR.

Exhibit 1.1 provides both raw adoption rates (direct from the database) and rates adjusted for the fact that the HIMSS-Dorenfest

survey is biased toward larger hospitals. Our adjustment weights the hospitals in the database to match the size distributions in the overall hospital population. We also estimated the adoption of HIT per hospital bed, to get a crude estimate of the share of the patient population exposed to HIT technology.

The largest determinant of whether or not a hospital has adopted an EMR system is whether it is part of a multi-hospital system whose other hospitals have adopted (the correlation is about 80 percent for EMR and CPOE). This association implies that the decision to adopt is made at the system level, not at the level of the individual hospital.

Exhibit 1.2 shows the variation in hospital adoption rates across several hospital characteristics. Non-profit hospitals are farther ahead in the adoption of clinical HIT than are for-profit hospitals. The real leaders in the HIT-adoption process are academic and pediatric hospitals, and large hospitals, although size seems to be a factor only for non-profit hospitals. The share of Medicare patients seems to be a considerably negative factor in the adoption of clinical HIT, but the share of Medicaid patients does not.

Hospitals with an equity interest in a health maintenance organization (HMO) or preferred provider organization (PPO) insurance products (or whose parent healthcare system has such an interest) have considerably higher adoption of clinical HIT than do those hospitals with no equity interest in an HMO or a PPO. These differences are more marked between for-profit hospitals than between non-profit hospitals. Alternative measurements, such as revenue from managed care sources by healthcare system, support the same positive relationship with clinical HIT adoption.

About 15 percent of all community hospitals are managed[6] rather than owned or leased by their parent system. These contract-managed hospitals have half the HIT-adoption rate of owned hospitals. This difference is partially explained by the fact that contract-managed hospitals are about half the size of owned hospitals, are predominantly rural, and are often government-owned.

The difference in EMR and CPOE adoption between urban and rural locations is relatively small. However, urban hospitals are much more likely to adopt PACS (42 percent versus 22 percent).

The degree of competition[7] in the market (inversely, its concentration) correlates with adoption (Exhibit 1.3). Non-profit hospitals are more likely to have PACS, CPOE, and EMR when their market is more competitive. For-profits are more likely to have PACS in competitive markets, but less likely to have EMR.

The multivariate regression analysis of clinical HIT adoption in non-profit and for-profit hospitals largely supports univariate analysis and is summarized in Exhibits 1.4, 1.5, and 1.6.

HIT ADOPTION BY AMBULATORY PRACTICES

Exhibit 1.7 provides both raw adoption rates (direct from the database) and rates adjusted for the fact that the HIMSS-Dorenfest survey is biased toward larger physician practices. Our data on ambulatory practices are limited to those practices that are owned by healthcare delivery systems, which constitute less than one-fourth of office-based physicians in the United States. Our adjustment weights the physician practices in the database to match the size distributions in the overall provider population. We also estimated the adoption of HIT per ambulatory physician, to get a crude estimate of the share of the physician population exposed to HIT technology. This yields the estimate of 12% adoption per practice or 17% adoption per physician. Our estimate is considerably lower than the estimates from the alternative sources (Exhibit 1.10), despite a theoretical bias towards higher adoption among the practices owned by hospital systems. The overestimation in other surveys may be due to sample-selection and response bias. The HIMSS Survey of Ambulatory Technology (2004) estimates that 39% of the practices it surveyed have an EMR system installed. But, it is not based on random sample of practices and the response rate is quite low. Similar bias may cause the high estimate of ambulatory adoption rate of 42% in the survey by *Modern Physician*/PWC, which physicians were invited to complete on the *Modern Physician*

website. Preliminary results of the MGMA estimates for the adoption in the group practices are close to the corresponding estimates from the Dorenfest sample for practices of two and more physicians (20% installed versus 14-18%). MGMA estimates are based on an email survey, which was limited to MGMA members and group practices.[8] Comparing our estimates with the alternative surveys we believe that our estimates are conservative, and do not substantially overestimate the true adoption rate.

If an ambulatory practice is part of an integrated healthcare delivery system, then whether the practice has adopted is almost entirely determined by whether other practices in the system have adopted (the correlation is about 97 percent). Clearly, the decision to adopt is made at the system level, not at the level of the individual practice. Similarly, practices affiliated with EMR-equipped hospitals are twice as likely to have adopted as practices affiliated with hospitals not equipped with EMR.

Larger practices are more likely than small practices to have EMR systems (Exhibit 1.8). EMR adoption rates also vary by the type of ambulatory practice. The leaders in EMR adoption are multi-specialty clinics, with an EMR adoption rate of 33 percent—more than twice as high as adoption in single-specialty practices or primary care practices.

There is a strong correlation between ambulatory EMR adoption by the clinic and a high share of managed care revenues in the affiliated hospital system (Exhibit 1.9). As in the case of hospitals, a high share of Medicare revenues (but not Medicaid revenues) is associated with reduced ambulatory EMR adoption in the healthcare system.

2. EXTRAPOLATING EVIDENCE OF HEALTH INFORMATION TECHNOLOGY SAVINGS AND COSTS

This section quantifies potential national-level efficiency savings that might be obtained with HIT and associated health care changes, and compares them to the costs the nation would incur to realize those savings (*efficiency savings* are those savings resulting from the ability to perform the same task with fewer resources). It summarizes a more detailed technical report.[9]

We estimated the potential national-level efficiency savings as follows. A provider (a physician or a hospital) incurs a yearly expenditure B (the baseline cost) and uses a HIT application to reduce it by a percentage s. For example, a physician might spend $7,000 per year on transcription services (B=7,000) and, by adopting an electronic medical record system (EMR-S), be able to save 50 percent of that amount (s=0.5). We do not include savings accruing to providers who have adopted in, or prior to, year 2004. Let

N = the national number of providers.

p_t = the adoption rate in year t (that is, the fraction of providers who have adopted an EMR-S by year t).

We use the adoption curve described in Bower.[10] Then, the national savings in year t (for t>2004) are

$$S_t = sBN(p_t - p_{2004}) \qquad (2.1)$$

This expression does not account for the delay between the beginning of the implementation of an EMR-S and the time the implementation is complete and savings begin to materialize, but the effect of the delay is reflected in the results we show below. We have assumed that implementation lasts two years and four years in the outpatient and inpatient settings, respectively.

In general we used the average cost for B although in some cases, such as for LOS, we were more conservative.[11] In the short term certain costs are fixed and using the variable portion of the cost would lead to smaller estimates. However, in the long run we expect the infrastructure to change, eliminating some of the fixed costs. A growing trend toward outsourcing, such as the case for laboratory tests, generally means a low fixed cost so that the use of total cost is appropriate.

SOURCES OF EVIDENCE

We searched the literature for evidence we could use to insert into this simple model. Most of the literature findings came from peer-reviewed articles, although we also searched the gray literature (such as reports by government agencies or private organizations that are not reviewed and published in standard research publications). Values for the parameter s were the most difficult to find. We needed specific empirical evidence of the quantitative effects of HIT on outcome measures. The evidence also had to be attached to a specific segment of the healthcare system and a particular technological intervention so that it could be appropriately scaled. Exhibits 2.1 and 2.2 summarize the most significant, useful sources; a detailed description of the literature search can be found in Girosi et al.[12] We used the range of the findings about single effects to provide a standard deviation for the effect and used Monte Carlo simulation to represent this variation. For effects with more-limited evidence, we applied a similar dispersion, generally about 50 percent on each side of the mean.

Typically, we obtained values for the parameter B from sources on healthcare expenditures, such as the National Health Expenditures (NHE)[13] or the Healthcare Cost Report Information System (HCRIS) dataset;[14] we obtained N from physician and hospital associations, such as the American Medical Association (AMA) and the American Hospital Association (AHA). Whenever possible, we obtained multiple estimates for the parameters B and N (or their product), using different methods of calculations and performing several validating steps. We tried to be

conservative, erring on the side of underestimating the efficiency savings.

OUTCOME MEASURES

Since savings are a function of time, we introduced the following measures of savings:

- **Potential savings**: the yearly savings that could be realized once adoption reaches 100 percent.
- **Cumulative savings**: the potential total savings that could be realized over a period of 15 years, starting in year 2004. Future savings can be discounted at a rate r, which is the interest rate minus the growth rate of healthcare expenditures. We have conservatively chosen $r = 0$, assuming that the interest rate and the growth rate of healthcare expenditures cancel each other.
- **Mean yearly savings**: the average potential savings that could be realized over a period of 15 years, starting in year 2004.

ESTIMATING THE POTENTIAL BENEFITS OF HIT

Our detailed technical report describes the range of results we obtained from our Monte Carlo simulation. Exhibit 2.3 shows mean potential efficiency savings from ten different sources. For each of these categories of savings, we have computed the product sBN and projected the savings forward according to Equation (2.1). Exhibit 2.4 shows the portion of these savings that could accrue to Medicare, under the assumption that each payor would benefit in proportion to its current level of expenditures as reported in the NHE.

ESTIMATING THE COST OF HIT

Inpatient

We built a model of the cost of a generic inpatient EMR-S using 27 observations (Exhibit 2.5). The model estimates how much a hospital is likely to spend on a generic EMR-S (which includes elements of computer order entry, patient records, and picture archive and communication

systems), given its size, operating expenses, and teaching status. The cost consists of a one-time implementation cost and an annual maintenance cost, which we estimate to be 30 percent of the one-time cost.

To project the cost of EMR-S acquisition by hospitals, we used the adoption curve described in Bower[15] and simulated the adoption of EMR-S by hospitals over time, using hospital-level data from the HCRIS dataset. The simulation generated estimates of how much hospitals would spend on EMR-S during each of the next 15 years (excluding hospitals that had started to implement an EMR-S during or before the year 2004). We performed sensitivity analyses on all the parameters of the model, including the specification of the regression model that links the cost of EMR-S to the hospital characteristics. Exhibit 2.6 shows selected results.

Outpatient

We have estimated the physician cost of an outpatient EMR-S using a dataset collected by Kirk Voelker, MD,[16] which documents cost and features of more than 80 EMR-S products. We augmented these data with data found in Anderson (2004),[17] and after having excluded products with very limited capabilities and adjusted for additional hardware costs and productivity losses, we ended up with a table with 82 entries for the one-time cost of EMR-S. Maintenance costs were modeled as 20 percent of the one-time cost. Exhibit 2.7 shows the resulting distribution of outpatient EMR-S costs. We projected physicians’ expenditures on EMR-S by assigning to each physician an EMR-S whose cost was randomly drawn from our dataset and pacing the adoption according to Bower’s adoption curve.[18] Effects related to economies of scale were not included because the distribution of practices is dominated by the small practices. Exhibit 2.8 shows a two-way sensitivity analysis for different measures of cost.

Cost of Connectivity

Connectivity is the infrastructure necessary to allow entities belonging to the healthcare system to share patients' clinical information. The only well-documented example of such a system is the Santa Barbara County Data Exchange.[19] We used it as a baseline for estimating how much it would cost to "connect" the entire country. We used two alternative methods to scale these results to the national level, obtaining very similar results. We also validated these results with data found in the literature. Assuming that the current level of connectivity is low (5 percent) and that maintenance costs are 30 percent of the fixed cost, we found that, over the next 15 years, the cumulative cost of connectivity of a type similar to that in Santa Barbara is $6 billion, for a mean yearly cost of $0.4 billion.

COMPARING COSTS AND POTENTIAL BENEFITS AT THE NATIONAL LEVEL

Exhibit 2.9 shows two different measures of net national benefits of both inpatient and ambulatory EMR-S. Net potential benefits were computed as the difference between potential benefits and costs, each estimated using the methodology described above.

INCENTIVES FOR ADOPTION

Standard adoption theory provides us with a model for future demand for EMR-S under constant-price conditions. If the price elasticity is known, it is possible to simulate the effect of financial incentives for the adoption of EMR-S on the HIT-adoption curve. We simulated two kinds of financial incentives, one for physicians and one for hospitals. For physicians, we assumed that the provider who acquires an EMR-S in a certain time frame receives a payment for each visit he/she performs in the three years following the acquisition. For hospitals, we assumed that the hospital that acquires an EMR-S gets reimbursed for a certain percentage of the cost or receives a payment for every bed day of utilization for a period of four years. In both cases, the effect of the incentive is to reduce the cost of EMR-S and quicken the pace of adoption. Using the modified adoption curve, we were able to estimate both costs and potential benefits of the incentive. The potential

benefit comes from the fact that providers could start realizing the HIT efficiency savings sooner, enjoying them for a longer period.

Since the price elasticity of demand is not known, we relied on sensitivity analyses and Monte Carlo simulations to show that, under very mild conditions, the potential benefits of the incentives are several times greater than the costs for both inpatient subsidies and per-encounter payments to physicians. We also simulated the effect of an across-the-board 50-percent decrease in the price of all EMR-S, which takes place over 5 years, starting in 2004. Using an elasticity of demand of –0.5, we estimated a net potential benefit of $29.6 billion from increased adoption, with an 8.8-percent average increase in adoption rates over 15 years.

3. ANALYSIS OF HEALTHCARE INTERVENTIONS THAT CHANGE PATIENT TRAJECTORIES

A *patient trajectory* is the sequence of events that involves the patient with the healthcare system. In this section, we summarize our analysis of the following interventions in the healthcare system that affect patient trajectories:[20]

- Implement computerized physician order entry (CPOE) as a means of reducing adverse drug events (ADEs) in both inpatient and ambulatory settings. ADE avoidance among inpatients reduces lengths of stays in the hospital. In an ambulatory setting, ADE avoidance may eliminate some hospital admissions and some office visits to physicians.
- Increase the provision of the following preventive services: influenza and pneumococcal vaccinations and screening for breast, cervical, and colorectal cancer. Vaccinations prevent some cases of influenza and pneumonia. Some people (mostly elderly) are hospitalized with these diseases. Screening identifies cancers earlier, improving survival and allowing less-extreme treatments to be employed.
- Enroll people with one of four chronic illnesses—asthma, chronic obstructive pulmonary disease (COPD), congestive heart failure (CHF), or diabetes—in disease-management programs. Disease management reduces exacerbations of a chronic condition that can put the patient in the hospital.
- Persuade people to adopt healthy lifestyles and estimate the health outcomes if everyone controlled their weight, stopped smoking, ate a healthy diet, exercised, and controlled their blood pressure and cholesterol as necessary with medications. Lifestyle changes can reduce the incidences (and ultimately the prevalences) of a number of conditions that require substantial amounts of healthcare.

Healthcare information technology (HIT) may facilitate these interventions through several mechanisms. First, HIT can help identify

the consumers eligible for the intervention by scanning an electronic database--e.g., of medical records or claims data. Second, HIT can help consumers and providers adhere to "improved care" guidelines—for example, by reminding providers and patients when particular services are due and by providing instruction. Third, HIT may increase efficiency--e.g., using automation to reduce the need for home monitoring of patients by a nurse. Finally, HIT makes it easier to record and analyze the performance of an intervention, so that it can be improved over time. For example, one can use data collected on today's medical practices to develop still-better care guidelines.

Information technology is an *enabler*; it makes possible new ways of working.[21] But it does not guarantee that an enterprise will adopt new work processes, neither in healthcare[22] nor in other sectors of the economy.[23] We have defined our interventions in terms of changes in the way the healthcare system works. Our results are therefore estimates of what *could* be, and not predictions of what *will* be.

ESTIMATING THE EFFECTS OF INTERVENTIONS

We estimated the potential effects of each intervention on healthcare utilization (e.g., hospital stays, office visits, and prescription drug use), healthcare expenditures, and population health outcomes (workdays or schooldays missed, days spent sick in bed, mortality). By *potential,* we mean the maximum effect that could be achieved, assuming that everybody eligible to participate did so as effectively as possible. Although we do not expect the entire potential to be achieved, it provides an upper bound.

For each intervention, we first established baseline values for utilization, expenditures, and population health. For most interventions, our baseline was a database of patient trajectories from several years of the Medical Expenditure Panel Survey (MEPS).[24] Next, we modified the baseline to reflect the presence of the intervention, basing our modifications on the published literature. We estimated the effects of the intervention to be the difference between the baseline and the modification.

We estimated the effects our interventions would have in the healthcare system of the year 2000. In essence, we imagined that somebody changed the healthcare system back in, say, 1980, and asked how the data collected by MEPS in 1996–2000 (the data we used to construct our trajectory database) would have been different.

While we devised adjustments for future demographic changes to the year 2020, we found that they told us nothing new about the interventions. We chose not to speculate about other possible changes to the healthcare system (e.g., technological changes, or changes in attitudes about end-of-life care). An investigation of these factors was far beyond the scope of the present project.

POTENTIAL EFFECTS OF THE INTERVENTIONS

Preventing Adverse Drug Events in the Inpatient Setting

Exhibit 3.1 shows selected potential effects of installing CPOE in hospitals nationwide. To estimate these effects, we took an overall rate of ADEs per patient-day from the literature,[25,26,27,28,29] and we distributed it to hospital stays with diagnoses that a physician identified for us as being most likely to be associated with ADEs. For this intervention, we did not use a baseline developed from MEPS data. Instead, descriptions of hospital stays (including diagnoses and an identification of the hospital hosting the stay) came from the National Inpatient Sample (NIS), a public-use file available from AHRQ's Healthcare Cost and Utilization Project (HCUP).[30] Hospital characteristics came from the American Hospital Association (AHA) annual survey of the nation's hospitals.[31]

Preventing Adverse Drug Events in the Ambulatory Setting

Exhibit 3.2 shows the potential effects of installing CPOE in physician practices nationwide. To estimate these effects, we took from the literature an overall rate for ADEs per visit to a physician's office,[32,33,34] and we distributed them to visits where problem drugs were prescribed. Our baseline descriptions of office visits came from the National Ambulatory Medical Care Survey (NAMCS).[35]

Vaccination and Disease Screening

Reminders provided by electronic medical record systems have been shown to increase the likelihood that patients receive influenza and pneumococcal vaccinations, and screening for breast cancer, cervical cancer, and colorectal cancer. To estimate the effects of these preventive interventions, we selected the population from our MEPS analysis file that the United States Preventive Services Task Force (USPSTF) recommends should receive each service.[36,37,38,39] We combined these data with information from the published literature on the fraction of people who currently receive the service[40] and on costs and benefits per instance of the service.[41,42,43,44,45,46,47,48]

Exhibit 3.3 shows our estimates of some of the effects of these five preventive services. These estimates assume that the services are rendered to 100 percent of people not currently complying with the USPSTF recommendation. We did not presume that HIT will lead to this magnitude of compliance. However, the exhibit provides the information that such interventions do not lead to savings, and that increases in compliance through HIT could provide significant health benefits.

Chronic Disease Management

We examined management programs for four conditions: asthma, COPD, CHF, and diabetes. We modeled our disease-management interventions on Dr. Ed Wagner's Chronic Care Model,[49,50] which works by substituting regular office visits to a physician and prescription medications for costly hospitalizations and visits to the hospital emergency department. Our baseline consisted of all people with the target condition in our MEPS database of patient trajectories. We assumed that nobody in the baseline participated in disease management. We modified the numbers of events of various kinds (e.g., hospital stays, office visits to physicians, prescriptions), using data from the literature.[51,52,53,54] Exhibit 3.4 shows selected effects, assuming that 100 percent of the people eligible for each disease-management program participate. Patients with lower severity conditions require less intensive (hence

less costly) management; our disease management costs assume today's mix of severities of the targeted condition.

Effects of Lifestyle Change

Exhibit 3.5 shows the enormous benefits that would result in the long run if everybody controlled their weight, stopped smoking, ate a healthy diet, exercised, and controlled their blood pressure and cholesterol as necessary with medications. We modeled this program of lifestyle change by reducing the prevalence—the number of cases in the population at a point in time—of selected chronic medical conditions in the analysis database. Smoking cessation can reduce the incidence of COPD and smoking-related cancers.[55] Combinations of diet, exercise, weight control, and medications can control hypertension and hyperlipidemia, which are risk factors for more-serious cardiovascular conditions.[56,57] Weight control can reduce the incidence of diabetes and its complications.[58,59] Over the long term, a reduction in the incidence of a condition will result in a reduction in its prevalence. Exhibit 3.5 assumes that lifestyle changes reduce the prevalence of each condition to 40 percent of its current level.

Effects of a Combined Disease-Management and Lifestyle-Change Program with Realistic Participation Rates

To obtain more-realistic estimates than those shown in Exhibits 3.4 and 3.5, we scaled down participation. Experience shows that patients comply with medication regimes about 50 percent of the time on average, although there is a great deal of variation from one study to another. Studies show that patients comply with their physician's lifestyle recommendations only about 10 percent of the time.[60,61] Exhibit 3.6 shows the benefits realized by a combined program of disease management and lifestyle change if we apply a range of participation rates.[62]

CAN THE POTENTIAL BENEFITS BE REALIZED?

We estimated the *potential* benefits of our interventions, by which we mean the effect that could be achieved if everybody adopted the necessary HIT systems and used them effectively. But these behaviors

are not guaranteed to happen, and the data reflect this; the literature reports many failed HIT projects. Aspects of implementation that go poorly at first may be improved over time, however, and we have taken our data for estimating potential benefits from the literature on successes. It seems unduly pessimistic to assume that failures are forever. But it is entirely plausible that some portion of the potential benefits will remain beyond reach.

The difficulty and uncertainty of achieving the benefits of the interventions we have considered in this section vary inversely with the size of the potential benefits. Using CPOE to reduce inpatient ADEs has the smallest potential benefits, followed by USPSTF-recommended preventive measures, ambulatory CPOE, disease management, and lifestyle change, in that order. In the same order, both the evidence that HIT can help and the experience of designing and using helpful HIT go from stronger to weaker. People have designed and implemented HIT in support of ADE reduction, improving preventive services, and disease management, so one need not start from scratch. We found little or no guidance for how to design and implement HIT systems that promote lifestyle change.

The farther along the progression one moves, the more connectivity and integration the appropriate HIT systems will likely need. Stand-alone CPOE and EMR systems operating in single-provider organizations can reduce ADEs and facilitate preventive services, although some degree of connectivity ought to improve their performance. Disease management requires coordination of multiple providers and communication with the patient. Consumers must be the primary agents of lifestyle change, so a HIT system that promotes lifestyle change (once we discover what it looks like) must integrate the consumer into the healthcare system.

Finally, interventions farther along the progression will require greater transformation of the healthcare system. The healthcare system is currently fragmented, with numerous independent providers. More connectivity and integration requires more inter-provider coordination. The most profound transformation, however, would make the consumer his own primary care provider. Healthcare would cease to be a commodity that professionals deliver to passively accepting patients. Instead,

consumers and professionals would provide care collaboratively. Such a revolutionary change will not happen quickly or easily.

EXHIBITS

Exhibit 1.1:

Raw and Adjusted Estimates of Clinical HIT Adoption

	HIMSS-Dorenfest		Population-Adjusted		
	Installed	Adopted	Installed	Adopted	Adopted per bed
Partially Integrated Inpatient EMR	21%	27%	20%	25%	28%
Upper-Limit Inpatient EMR	26%	32%	25%	30%	34%
Inpatient CPOE	10%	17%	9%	15%	17%
Radiology PACS	28%	36%	23%	30%	43%

Exhibit 1.2:

Adoption Rates of HIT Applications, by Category

	No. of Hosp	EMR Upper Limit	Part Integ EMR	Integ EMR	CPOE	PACS
Average adoption (Dorenfest sample)	3979	32.0%	26.8%	17.8%	17.0%	35.9%
Profit Status:						
For-profit	874	25.0%	18.0%	11.0%	4.0%	18.0%
Non-profit	3105	34.0%	29.0%	20.0%	21.0%	41.0%
Hospital Type:						
Long-Term Acute	110	10.0%	10.0%	10.0%	0.9%	3.0%
Critical Access	76	13.2%	9.2%	9.2%	15.8%	18.0%
General Medical	55	16.4%	12.7%	10.9%	10.9%	22.0%
General Medical & Surgical	3235	31.5%	26.1%	17.0%	15.5%	35.0%
Academic	343	44.0%	38.5%	28.9%	28.3%	59.0%
Pediatric	116	54.3%	48.3%	40.5%	45.7%	53.0%
Bed-size category:						
25 and fewer beds	216	20.8%	16.7%	13.0%	8.3%	18.5%
25-49 beds	590	25.3%	22.0%	14.4%	14.2%	19.0%
50-99 beds	682	29.9%	24.5%	15.7%	15.3%	22.3%
100-200 beds	1087	33.5%	27.8%	19.6%	15.4%	34.8%
200-300 beds	658	34.5%	28.3%	20.4%	21.4%	44.1%
300-400 beds	341	36.7%	31.4%	19.9%	18.5%	49.3%
400-500 beds	186	34.4%	30.1%	18.3%	23.7%	67.7%
500 and more beds	219	43.8%	37.9%	17.8%	25.1%	74.4%
Medicare share						
>50% of discharges	1286	27%	22.4%	14.5%	12%	24%
<50% of discharges	2348	35%	28.9%	19.5%	19%	41%
Medicaid share						
>25% of discharges	519	35%	30%	21%	19%	40%
<25% of discharges	3115	31%	26%	17%	16%	34%
Managed Care Status:						
PPO hospital	256	40%	33%	25%	24%	45%
PPO system	429	43%	34%	22%	20%	46%
HMO hospital	194	38%	32%	19%	30%	57%
HMO system	396	45%	35%	23%	25%	47%
not HMO or PPO	2334	29%	25%	17%	15%	32%
Contract-managed						
contract-managed	417	16%	14%	10%	10%	20%
not contract-managed	2566	35%	29%	19%	18%	40%

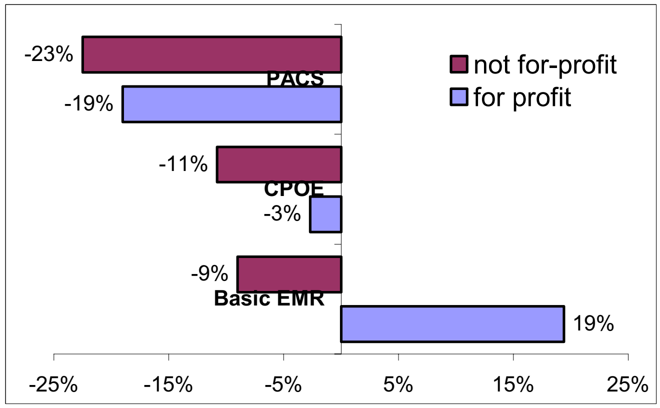

Exhibit 1.3: Correlation of HIT Adoption with the Index of Market Concentration (the Inverse of Competition), by the Profit Status of the Hospital

Exhibit 1.4:

Probit Regressions with Basic Independent Variables in Acute Care Hospitals

Hospital Type or Characteristic	EMR	CPOE	PACS
Log of adjusted admissions (size)	0.106***	0.059*	0.33***
For-profit	-0.26***	-1.06***	-0.647***
Rural	0.136**	0.013	-0.213***
Government-owned	0.005	-0.082	-0.015
Academic Status	0.168**	0.353***	0.332***
Pediatric	0.451**	0.811***	0.369*
Contract-managed	-0.481***	-0.227**	-0.12
Percentage of Medicare admissions	-0.697***	-0.893***	-0.171
Percentage of Medicaid admissions	-0.306	-1.08***	-0.93
HMO hospital	-0.127	0.177	0.273**
HMO system	0.185**	0.207**	-0.068
PPO hospital	0.211**	0.163	-0.003
PPO system	0.146*	-0.07	0.241***
R2	*5%*	*8%*	*13%*

NOTES:
*Coefficient is significant at the 10-percent significance level.
**Coefficient is significant at the 5-percent significance level.
***Coefficient is significant at the 1-percent significance level.

Exhibit 1.5:

Probit Regressions for Non-Profit Acute Care Hospitals

Hospital Type or Characteristic	EMR	CPOE	PACS
Log of adjusted admissions (size)	0.133***	0.050	0.329***
Rural	0.084	0.022	-0.161**
Academic Status	0.259***	0.357***	0.234**
Trainees per Staff	-3.245**	-0.006	2.588**
Pediatric	0.437**	0.849***	0.377*
Contract-managed	-0.420***	-0.403***	0.023
Percentage of Medicare admissions	-0.855***	-0.864***	-0.221
Percentage of Medicaid admissions	-0.460*	-0.996***	-0.169
HMO hospital	-0.141	0.198	0.277**
HMO system	0.181**	0.183*	-0.127
PPO hospital	0.284***	0.180	-0.031
PPO system	0.160*	-0.098	0.223**
Member of healthcare system	0.099	0.172**	0.148**
Number of hospitals in a system	0.000	0.002**	-0.001*

NOTES:
*Coefficient is significant at the 10-percent significance level.
**Coefficient is significant at the 5-percent significance level.
***Coefficient is significant at the 1-percent significance level.

Exhibit 1.6:

Probit Regressions for For-Profit Acute Care Hospitals

Hospital Type or Characteristic	EMR	CPOE	PACS
Log of adjusted admissions (size)	0.000	0.058	0.544***
Rural	0.714***	0.189	-0.514**
Academic Status	N/A	1.306**	0.347
Trainees per Staff	14.01**	N/A	-103.361**
Contract-managed	0.545	0.405	-0.080
Percentage of Medicare admissions	-1.099*	-1.359	0.858
Percentage of Medicaid admissions	0.429	-2.050	0.407
HMO hospital or system	0.046	N/A	0.325
PPO hospital or system	-0.510*	N/A	-0.037
Member of healthcare system	0.406	-0.986***	-0.099
Number of hospitals in a system	-0.006***	0.002	-0.002

NOTES:
*Coefficient is significant at the 10-percent significance level.
**Coefficient is significant at the 5-percent significance level.
***Coefficient is significant at the 1-percent significance level.
N/A = impossible to estimate because of low variation in the variable, small sample size.

Exhibit 1.7:

Raw and Adjusted Estimates of Clinical HIT Adoption

	HIMSS-Dorenfest		Population-Adjusted		
	Installed	Adopted	Installed	Adopted	Adopted per MD
Ambulatory EMR	13%	17%	9%	12%	17%

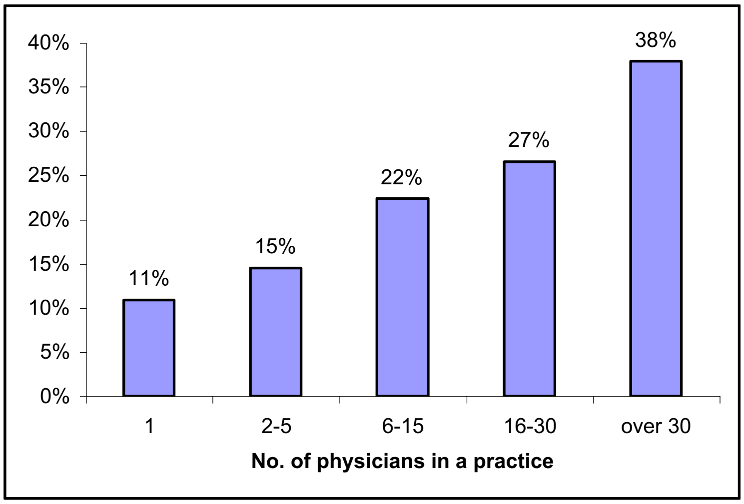

Exhibit 1.8: Adoption of HIT in Physician Practices, by Size

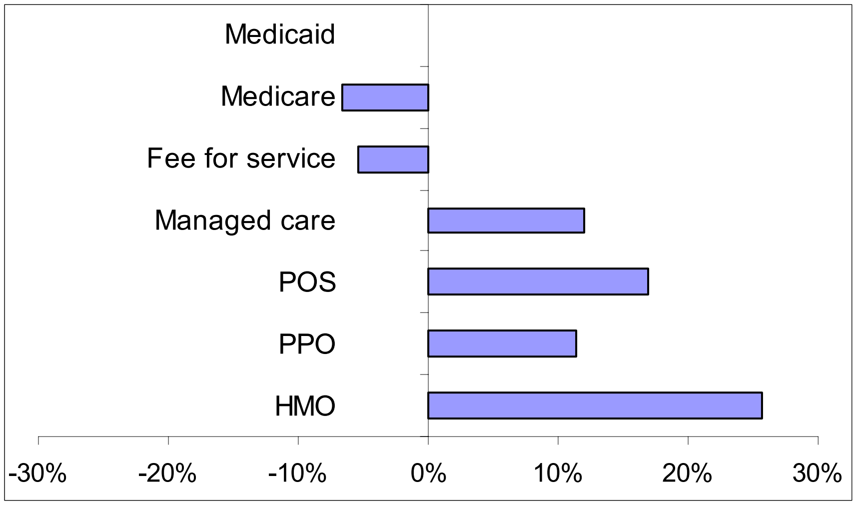

Exhibit 1.9: Correlation of Ambulatory EMR Adoption Rate in a Healthcare System, with the System's Revenue Source

Exhibit 1.10: HIT Adoption Rates in the Alternative Surveys

Alternative Survey	Inpatient EMR		CPOE		Ambulatory EMR	
	Installed	Adopted	Installed	Adopted	Installed	Adopted
This report	20%-25%	25%-30%	9%	15%	9%	12%
HIMSS, 2004		>56%				40%
MRI, 2004	21%-42%		17%		21%-42%	
Modern Physician, 2003						>42%
MGMA, 2004					20%	<40%
Deloitte, 2002					<13%	
Leapfrog, 2004			4%	<20%		

NOTE: The numbers in the table should not be compared directly without reference to the text, because the definition of the HIT systems and the sampling varies significantly among the surveys.

Exhibit 2.1:

Sources of Evidence for Efficiency Savings in the Inpatient Setting

Percentage Savings	Reference	Setting	Type of Study	Type of Publication
		Length of stay		
10.5%	1 Tierney, W., Miller, M., et al. (1993)[63]	Wishard Memorial Hospital, large public hospital	Randomized Control Trial	Peer-reviewed scientific publication
30.0%	2 Baldwin, F. (2003)[64]	Maimonides Medical Center, large teaching hospital	Pre/post	Medical informatic magazine
5.1%	3 Mekhjian, H., Kumar, R., et al. (2002)[65]	Ohio State University Health System, Academic Medical Center	Pre/post	Peer-reviewed, scientific publication
		Nurses' unproductive time		
10.8%	4 Wong, D., Gallegos, Y., et al. (2003)[66]	Long Beach Veteran Affairs Hospital, 10 beds ICU	Pre/post	Peer-reviewed scientific publication
10.0%	5 Ellingsen, G. and E. Monteiro (2003)[67]	Norwegian hospitals	Unknown; second-hand reporting from Norwegian Research Council report	Peer-reviewed scientific publication
16.0%	6 Fickel, L., (2001)[68]	Not known	Industry experts' opinion	Industry report
		Medical Records		
50.0%	7 Personnal communication			Hospital executives' opinion
		Drug Utilization		
15.2%	See #1 above			
		Laboratory Tests		
12.5%	See #1 above			
11.0%	8 Morgan, M. (2003)[69]	University Health Network, large academic hospital network	Pre/post	Conference presentation slides

Exhibit 2.2:

Sources of Evidence for Efficiency Savings in the Outpatient Setting

Percentage Savings	Reference	Setting	Type of study	Type of Publication
		Transcription		
48.2%	9 MacDonald, K. and J. Metzger (2002)[70]	Small pediatric urology practice	Pre/post	Commissioned study
95.0%	See #9 above	Small urology practice		
85.0%	10 Pifer, E., S. Smith, et al. (2001)[71]	Univ. of Pennsylvania Health System ambulatory practice	Pre/post	Medical informatic magazine
53.3%	11 Sandrick, K. (1998)[72]	Wasatch Internal Medicine and Family Practice (between 3 and 9 physicians)	Pre/post	Medical management magazine
19.6%	12 Bates, D., J. Studer, et al. (2000)[73]	Ambulatory practices of large teaching hospital	Pre/post	Conference proceedings
28.8%	13 Wang, S., B. Middleton, et al. (2003)[74]	Partners HealthCare Electronic Medical Record System	Pre/post	Peer-reviewed scientific publication
100.0%	14 MedicaLogic (2004)[75]	Two-physician practice, NH, 1996	Pre/post	Vendor website
100.0%	15 A4 Health Systems (2004)[76]	Three-physician practice, 1999	Pre/post	Vendor website
83.0%	16 CCA Medical (2004)[77]	Large family practice	Pre/post	Vendor website
100.0%	17 A4 Health Systems (2004)[78]	Four-physician family practice	Pre/post	Vendor website
96.0%	18 The Coker Group (2004)[79]	Pediatric pulmonology practice with 8 physicians, GA	Pre/post	Independent analysis prepared by The Coker Group for vendor

Exhibit 2.2, Continued:

Sources of Evidence for Efficiency Savings in the Outpatient Setting

Percentage Savings	Reference	Setting	Type of study	Type of Publication
	Chart Pulls			
35.5%	See #12 above			
100.0%	19 Lamberts, R. (2004)[80]	Small primary care practice	Pre/post	Physician's self-report
55.4%	20 Babbitt, N. (2004)[81]	3 ambulatory sites, 9 physicians	Pre/post	Physician's self-report
84.5%	See #20 above			
48.3%	21 Didear, K. and M. Kalata, (1998)[82]	13 ambulatory care facilities, 220 physicians	Pre/post	Peer-reviewed pub. for health info management professionals
49.0%	See #21 above			
53.4%	See #11 above			
50.0%	22 Renner, K. (1996)[83]	Clinic with 49 physicians	Pre/post	Peer-reviewed pub. of the Med. Gp. Manag. Assoc.
21.0%	23 United States General Accounting Office (2003)[84]	Integrated health care system with 50 clinics	Pre/post	Government report
100.0%	See #14 above			
80.0%	See #14 above			
84.3%	See #14 above			
	Radiology			
14.0%	See #13 above	Brigham and Women's Hospital, Partners Health Care System		
	Lab Tests			
14.3%	24 Tierney, W., M. Miller, et. al. (1990)[85]	Outpatient facility of Wishard Memorial Hospital (large public hospital)	Randomized Control Trial	Peer-reviewed scientific publication
40.0%	See #2 in INPATIENT table	Ambulatory facility of Maimonides Medical Center, large teaching hospital	Pre/post	Medical informatic magazine
13.0%	25 Tierney, W., C. McDonald, et al. (1987)[86]	Outpatient facility of Wishard Memorial Hosp.	Randomized Control Trial	Peer-reviewed scientific publication
	Drug Utilization			
15.0%	See #13 above	Brigham and Women's Hospital, Partners Health Care System		
5.0%	26 Cap Gemini Ernst & Young (2000)[87]	Analysis of data on behavior of 1,200 physicians, collected by IMS Health	Pre/post	Independent analysis prepared by Cap Gemini Ernst & Young for vendor
10.0%	27 Allscripts (2004)[88]	Practice-management company with 30 primary care physicians in 13 practice locations	Pre/post	Independent analysis prepared by Cap Gemini Ernst & Young for vendor

Exhibit 2.3:

Summary of Potential HIT-Enabled Efficiency Savings at the National Level. All figures in $ billion.

Cost Center	Potential Savings	Mean Yearly Savings	Cumulative Savings	Savings Year 5	Savings Year 10	Savings Year 15
Outpatient						
Transcription	1.9	0.9	13.4	0.4	1.2	1.7
Chart Pulls	1.7	0.8	11.9	0.4	1.1	1.5
Laboratory Tests	2.2	1.1	15.9	0.5	1.5	2.0
Drug Utilization	12.9	6.2	92.3	3.0	8.6	11.8
Radiology	3.6	1.7	25.6	0.8	2.4	3.3
Total	22.3	10.6	159.0	5.2	14.8	20.4
Inpatient						
Nurse Shortage	12.7	7.1	106.4	3.4	10.0	13.7
Laboratory Tests	3.0	1.6	23.4	0.8	2.2	2.8
Drug Utilization	3.7	2.0	29.3	1.0	2.8	3.5
Length of Stay	36.7	19.3	289.6	10.1	27.6	34.7
Medical Records	2.5	1.3	19.9	0.7	1.9	2.4
Total	58.6	31.2	468.5	16.1	44.5	57.1
Grand Total	80.9	41.8	627.5	21.3	59.2	77.4

Exhibit 2.4:

Summary of HIT-Enabled Savings That Could Accrue to Medicare. All figures in $ billion.

Cost Center	Potential Savings	Mean Yearly Savings	Cumulative Savings	Savings Year 5	Savings Year 10	Savings Year 15
Outpatient						
Transcription	0.4	0.2	2.7	0.1	0.3	0.3
Chart Pulls	0.3	0.2	2.4	0.1	0.2	0.3
Laboratory Tests	0.5	0.2	3.2	0.1	0.3	0.4
Drug Utilization	2.6	1.2	18.7	0.6	1.7	2.4
Radiology	0.7	0.3	5.2	0.2	0.5	0.7
Total	4.5	2.2	32.3	1.1	3.0	4.1
Inpatient						
Nurse Shortage	3.9	2.2	32.7	1.0	3.1	4.2
Laboratory Tests	0.9	0.5	7.2	0.3	0.7	0.9
Drug Utilization	1.1	0.6	9.0	0.3	0.9	1.1
Length of Stay	11.3	5.9	88.9	3.1	8.5	10.7
Medical Records	0.8	0.4	6.1	0.2	0.6	0.7
Total	18.0	9.6	143.8	4.9	13.7	17.5
Grand Total	22.5	11.7	176.1	6.0	16.7	21.7

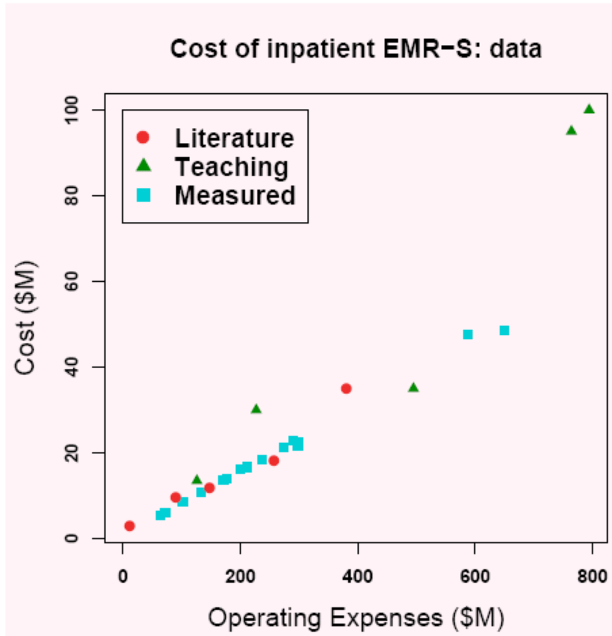

Exhibit 2.5: Cost of EMR-S Versus Hospital Operating Expenses for 27 Hospitals. Data marked "measured" correspond to data collected directly from hospitals; the other data were collected from the literature. We marked teaching hospitals because we thought they might have a different cost structure.

Exhibit 2.6:

Two-Way Sensitivity Analysis for Inpatient EMR-S Cost. The *initial adoption rate* is the estimated percentage of hospitals that adopted an EMR-S by year 2004. The *adoption time* is the years it takes to go from 10-percent adoption to 90-percent adoption.

Mean Yearly Cost ($ billion)

Adoption Time (years)	Initial adoption rate 15%	20%	25%
10.00	7.6	6.7	5.9
15.00	6.8	6.5	6.0
20.00	5.6	5.6	5.4

Cumulative Cost ($ billion)

Adoption Time (years)	Initial adoption rate 15%	20%	25%
10.00	114.3	101.0	88.1
15.00	102.5	97.4	90.3
20.00	83.3	83.6	80.8

One-Time Cost ($ billion)

Adoption Time (years)	Initial adoption rate 15%	20%	25%
10.00	31.8	27.3	23.3
15.00	33.5	30.4	27.3
20.00	29.8	28.6	26.7

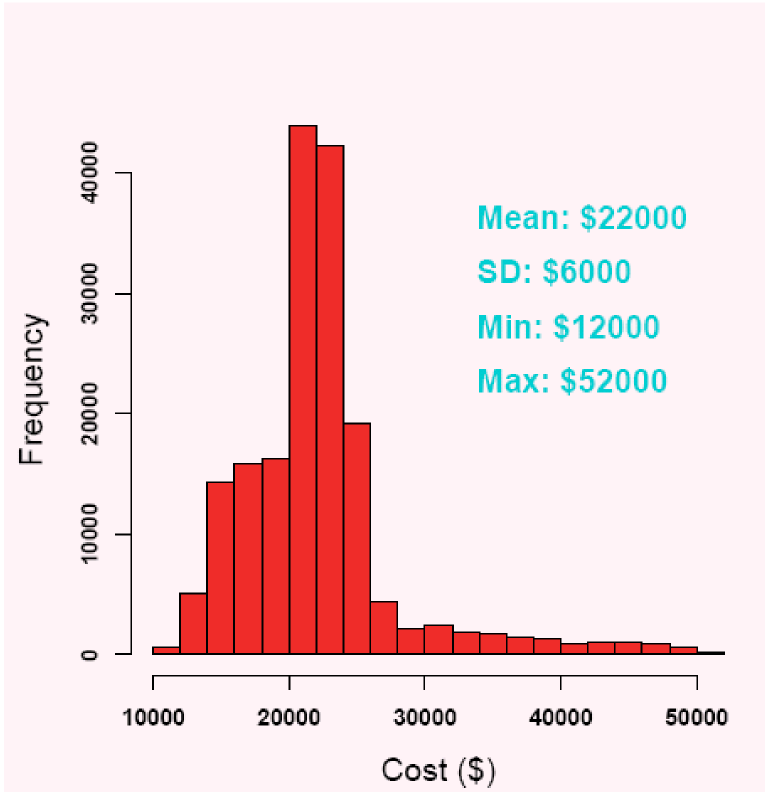

Exhibit 2.7: This Histogram Represents the Distribution of Physician's Cost for Outpatient EMR-S Associated with Our Dataset. In our simulations, each physician in the United States is randomly assigned a product with a cost chosen from this distribution.

Exhibit 2.8:

Two-Way Sensitivity Analysis for Outpatient EMR-S Cost. The *initial adoption rate* is the estimated percentage of physician practices that adopted an EMR-S by year 2004. The *adoption time* is the years it takes to go from 10-percent adoption to 90-percent adoption.

Mean Yearly Cost ($ billion)

Adoption Time (years)	Initial adoption rate 15%	20%	25%
10.00	1.4	1.4	1.3
15.00	1.1	1.1	1.1
20.00	0.8	0.9	0.9

Cumulative Cost ($ billion)

Adoption Time (years)	Initial adoption rate 15%	20%	25%
10.00	21.2	20.9	20.0
15.00	16.3	17.2	17.1
20.00	12.0	13.5	14.1

One-Time Cost ($ billion)

Adoption Time (years)	Initial adoption rate 15%	20%	25%
10.00	8.3	7.7	7.1
15.00	7.4	7.3	6.9
20.00	5.8	6.1	6.1

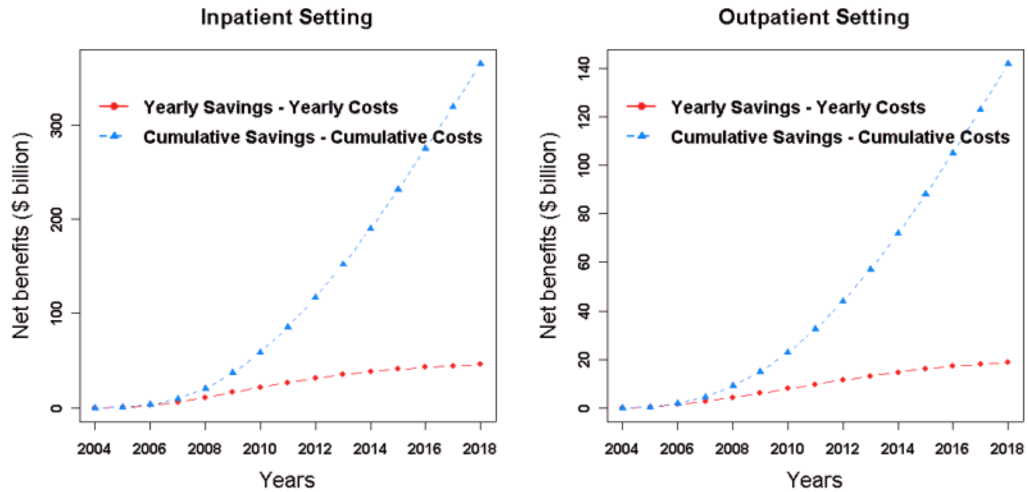

Exhibit 2.9: Net Potential Benefits (Savings – Costs) at the National Level for the Inpatient and Outpatient Setting. Circular dots refer to yearly benefits; triangular dots refer to cumulative benefits.

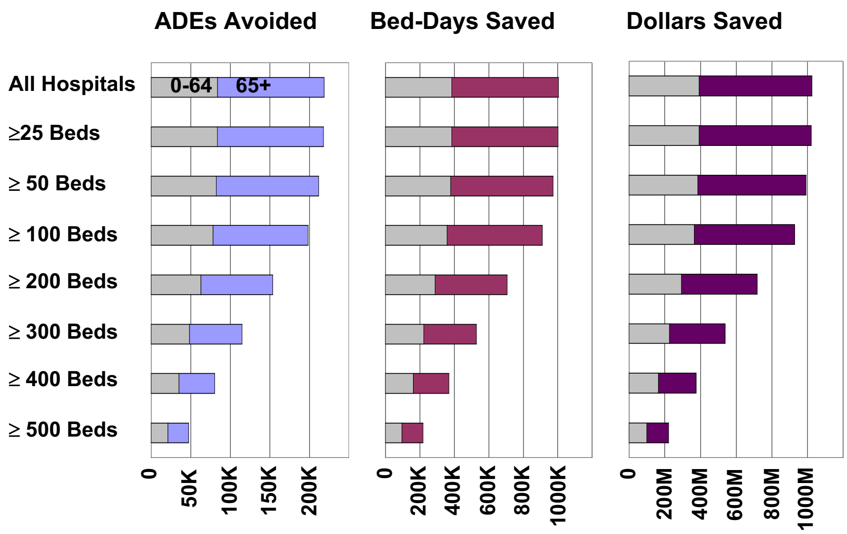

Exhibit 3.1: Potential Annual National-Level Effects of Using CPOE to Avoid Inpatient ADE, for Patients 0-64 Years Old and 65 Years Old and Over

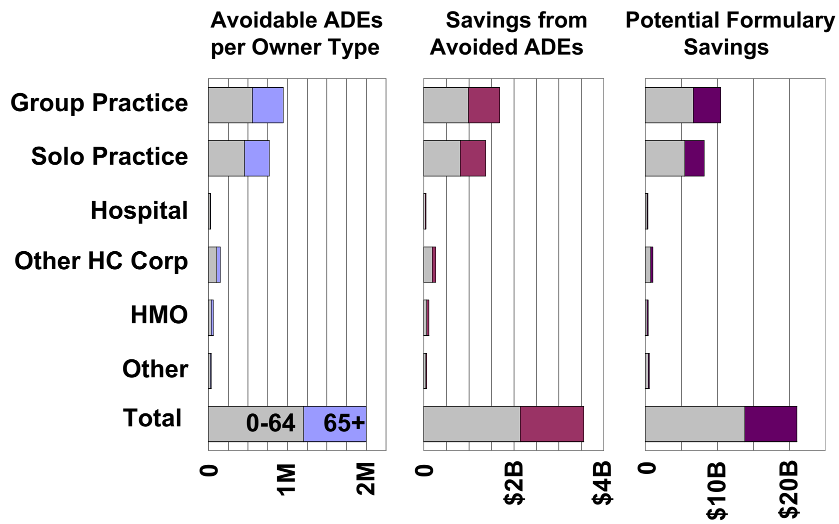

Exhibit 3.2: Potential Annual National-Level Effects of Implementing Ambulatory CPOE in Physicians' Offices, for Patients 0-64 Years Old and Patients 65 Years Old and Over

Exhibit 3.3:

Summary Results for Five Preventive Services (Assumes 100-Percent Participation)

	Influenza Vaccination	Pneumococcal Vaccination	Screening for Breast Cancer	Screening for Cervical Cancer	Screening for Colorectal Cancer
Program Description					
Target Population	65 and older	65 and older	Women 40 and older	Women 18–64	50 and older
Frequency	1/yr	1/lifetime	0.5–1/yr	0.33–1/yr	0.1–0.2/yr
Population Not Currently Compliant	13.2 M	17.4 M backlog; 2.1 M new persons/yr	18.9 M	13 M	52 M
Financial Impacts					
Program Cost (with 100% compliance)	$134 M to $327 M/yr	$90 M/yr	$1,000 M to $3,000 M/yr	$152 M to $456 M/yr	$1,700 M to $7,200 M/yr
Financial Benefits	$32 M to $72 M/yr	$500 M to $1,000 M/yr	$0 to $643 M/yr	$52 M to $160 M/yr	$1,160 M to $1,770 M/yr
Health Benefits					
Reduced Workdays Missed	180,000 to 325,000/yr	100,000 to 200,000/yr			
Reduced Days Abed	1.0 M to 1.8 M/yr	1.5 M to 3.0 M/yr			
Deaths Avoided	5,200 to 11,700/yr	15,000 to 27,000/yr	2,200 to 6,600/yr	533/yr	17,000 to 38,000/yr
Life-Years Gained				13,000/yr	138,000/yr

Exhibit 3.4

Annual Potential Effects of Four Disease-Management Programs (Assumes 100-Percent Participation)

	Under 65	65 and older	Total
Population (millions)	17.1	7.7	24.8
Utilization (millions)			
Inpatient stays	-1.4	-2.2	-3.6
Inpatient nights	-8.7	-17.6	-26.3
Hosp Outpatient + ER Visits	-3.2	-1.7	-4.9
Office Visits	-26.4	-20.3	-46.7
Disease-Mgt Visits	47.9	32.0	80.0
Expenditures ($ billion)			
Hospital	-$11.0	-$19.1	-$30.1
Physician	-$3.9	-$4.6	-$8.5
Program cost	$4.6	$3.9	$8.5
Rx	$1.3	$0.6	$1.9
Total	-$9.0	-$19.3	-$28.3
Days Affected (millions)			
Schooldays lost	-12.9	0.0	-12.9
Workdays lost	-25.9	-2.3	-28.2
Total days abed	-135.4	-109.2	-244.6
Mortality (thousands)			
Deaths	-102.6	-291.4	-394.1

Detail may not add to total due to rounding.

Exhibit 3.5:

Annual Potential Effects of Lifestyle Changes
(Assumes 100-Percent Participation)

	Under 65	65 and older	Total
Population (millions)	244.8	37.3	282.1
Utilization Measures (millions)			
Inpatient Stays	-3.2	-3.9	-7.1
Inpatient Nights	-18.6	-30.6	-49.2
Hosp Outpatient + ER Visits	-8.8	-3.7	-12.5
Office Visits	-63.2	-54.8	-118.0
Expenditures ($ billions)			
Hospital	-$31.8	-$39.9	-$71.7
Physician	-11.7	-11.4	-23.1
Rx	-16.2	-13.4	-29.6
Other	-4.4	-9.9	-14.3
Total	-$64.1	-$74.6	-$138.7
Days Affected (millions)			
Schooldays Lost	-1.6	0.0	-1.6
Workdays Lost	-39.4	-2.5	-41.9
Total Days Abed	-132.1	-125.1	-257.3
Mortality (thousands)			
Deaths	-119.4	-280.4	-399.8

Detail may not add to total due to rounding.

Exhibit 3.6:

Combined Potential Effects of Disease Management and Lifestyle Change for Various Participation Rates

	Case A	Case B	Case C	Case D	Case E
Participation Rates (Percent)					
Disease Management	100%	80%	80%	50%	50%
Lifestyle Change	100%	50%	20%	50%	20%
Utilization Measures (millions)					
Inpatient Stays	-8.4	-5.5	-4.0	-4.8	-3.0
Inpatient Nights	-57.8	-38.6	-28.1	-33.3	-21.2
Hosp Outpatient + ER Visits	-14.7	-9.1	-6.0	-8.0	-4.7
Office Visits	-102.9	-39.7	0.1	-46.9	-8.8
Expenditures ($ billions)					
Hospital	-$81.2	-$51.7	-$35.1	-$45.8	-$27.3
Physician	-$23.2	-$11.6	-$4.6	-$11.6	-$4.6
Rx	-$28.2	-$13.5	-$4.5	-$14.0	-$5.0
Other	-$14.3	-$7.2	-$2.9	-$7.2	-$2.9
Total	-$146.9	-$83.9	-$47.1	-$78.5	-$39.9
Days Affected (millions)					
Schooldays lost	-13.1	-10.6	-10.4	-6.9	-6.6
Workdays lost	-59.2	-39.1	-29.2	-32.3	-21.4
Total days abed	-366.5	-270.2	-225.5	-217.1	-160.2
Mortality (thousands)					
Deaths	-516.1	-404.0	-350.8	-327.5	-249.2

Detail may not add to total due to rounding.

ENDNOTES

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[1] The section summarizes a more detailed report: K. Fonkych, and R. Taylor, *The State and Pattern of Health Information technology Adoption*, RAND Corporation, MG-409-HLTH, 2005. Available at http://www.rand.org/publications/MG/MG409/.

[2] *Healthcare Information and Management Systems Society (HIMSS) AnalyticsSM Database* (formerly the Dorenfest IHDS+TM Database), second release, 2004 (description available at http://www.himss.org/DorenfestInstitute/default.aspx).

[3] American Medical Association (AMA), *Medical Group Practices in the US,* Chicago, Ill., 2002.

[4] American Medical Association, *Physician Socioeconomic Statistics,* Chicago, Ill., 2003.

[5] American Hospital Association (AHA), *Annual Survey Database,* Fiscal Year 2002.

[6] Under contract-management, a hospital's board of trustees retains an outside organization to manage the facility, and, usually, that organization also makes decisions on HIT investment.

[7] The inverse of competitiveness is measured by the Hirschman-Herfidahl Index (HHI) of market concentration, which is equal to the sum of each hospital's squared market share based on hospital beds over hospitals within a hospital market. The market is measured as a radius that covers 75 percent of a hospital's admissions. The competition is higher when HHI is lower, indicating that there are more hospitals in the market and that their market shares are more even.

[8] More-representative estimates may be derived from a random sample of 16,000 groups. The groups will be mailed paper surveys, and the MGMA data should be available by March 2005.

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